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DRAINAGE LAYOUTS

"Wherever systematic drainage is needed, a carefully thought out and recorded plan for the whole farm should precede the digging of any ditches."

By
VIRGIL OVERHOLT
Extension Specialist in Agricultural Engineering
The Ohio State University

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DRAINAGE LAYOUTS

It is estimated that 15 percent of the tile drainage done in Ohio consists of replacement work. Numerous strings of tile had from time to time been run here and there to catch the "wet spots." Later it became evident that the whole farm needed systematic drainage. It was seldom possible to make the old tile lines work into any efficient system for the entire farm. The usual result was that the old "hit or miss" drains were ignored and a new system planned without regard to what had already been done. Had there been a carefully thought out plan before a single foot of ditch was dug this needless waste could have been avoided. The planning of a complete system for a whole farm does not mean that the tile must all be put in during a single season. But whatever is done from time to time will constitute a part of what will eventually be a complete system.

SOME GENERAL PRINCIPLES OF DRAINAGE

A drainage system should be as simple as the topography of the ground permits. As a general statement it may be said that mains should be short, the laterals long, and outlets few as possible. In most cases the mains will follow the natural depressions, but should be free from sharp bends. The natural lay of the ground will often make long, irregular mains necessary, but long mains and short laterals are often found where shorter mains and longer laterals would have meant more economical drainage. As a rule, the laterals should follow the direction of greatest slope toward the mains. But strict adherence to this principle may make the drainage system too complicated.

A main will act as a lateral to drain the land on each side of itself for a distance equal to one-half the spacing of the laterals. Whenever a lateral passes thru land drained by the main, that land is said to be double-drained. Well planned drainage systems have a minimum of double-drainage.

It is often much easier to lay out a simple drainage system on comparatively level ground than on rolling ground. Some fields have numerous knobs and depressions. The simplest way to handle such conditions will usually be to run a main thru each depression, and then run the laterals straight thru from one end of the field to the other, connecting with the mains in the depressions and breaking the grade at the crest of the knoll. Thus a single lateral may discharge into two or more mains, but all laterals will be parallel.

APPLICATION OF PRINCIPLES

In Figs. 1, 2, and 3 are shown three methods of draining a 20-acre field. The field is 80 rods long by 40 rods wide, with a gradual slope toward the bottom of the field. It is assumed that the character of the soil is such as to require a spacing of 50 feet for the laterals. In Fig. 1 a main has been placed lengthwise thru the field with the laterals coming in from both sides. Such a drainage scheme is known as the herringbone system. In Fig. 2 the main has been placed along one side of the field 1½ rods from the fence. Laterals enter the main from one side only. This is known as the gridiron or parallel system. In Fig. 3 the main is shown across the lower end with laterals running lengthwise of the field. This is also a gridiron system. It will be noted that this system has a minimum length of main and a maximum length of laterals. Any complete system will usually be a combination of these types of layout.

A comparison of these three systems with respect to length of main, length of laterals, number of connections of laterals to main, and amount of double-drainage is shown in the following table:

Comparison of Three Systems of Drainage

	Fig. 1	Fig. 2	Fig. 3
Length of main	80 rds.	80 rds.	40 rds.
Total length of laterals	1000 rds.	1000 rds.	1000 rds.
Number of connections	54	27	13
Amount of double drainage	240 sq. rd.	120 sq. rd.	60 sq. rd.

For purposes of further comparison let us assume that the main tile cost $70 per 1000 feet, 4-inch laterals $30 per 1000 feet, digging the trench, laying the tile, and refilling, 50 cents per rod, and connections 40 cents each. We then have:

Comparison as to Cost of Installation

	Fig. 1	Fig. 2	Fig. 3
Laterals	$ 495.00	$ 495.00	$ 495.00
Main	92.40	92.40	46.20
Connections	21.60	10.80	5.20
Trench	540.00	540.00	520.00
Total	$1,149.00	$1,138.20	$ 1,066.40

From this table it may be seen that the system shown in Fig. 3 will cost $71.80 less than that shown in Fig. 2, and $82.60 less than in Fig. 1. This is a saving of $4.13 per acre in favor of gridiron

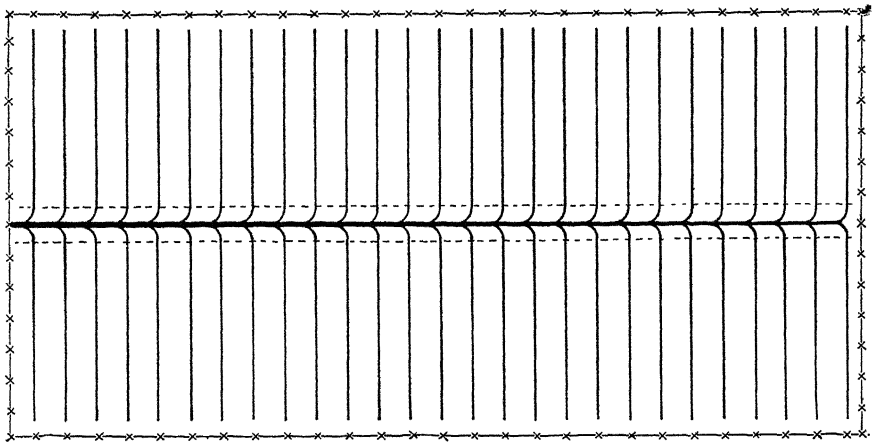

FIG. 1

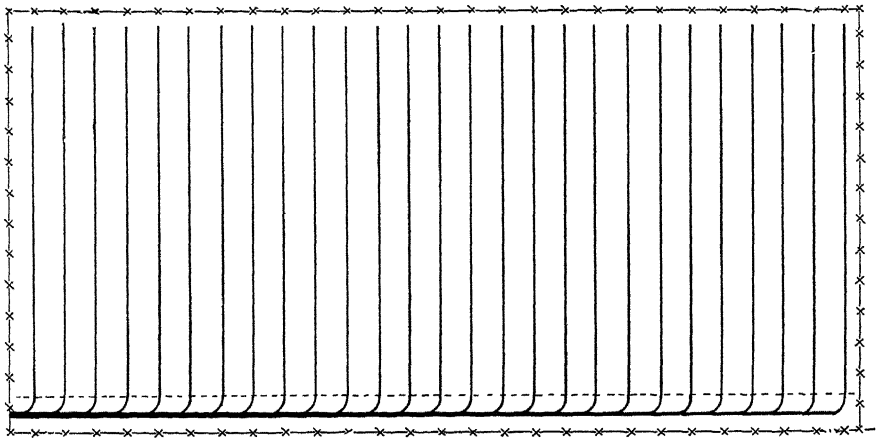

FIG. 2

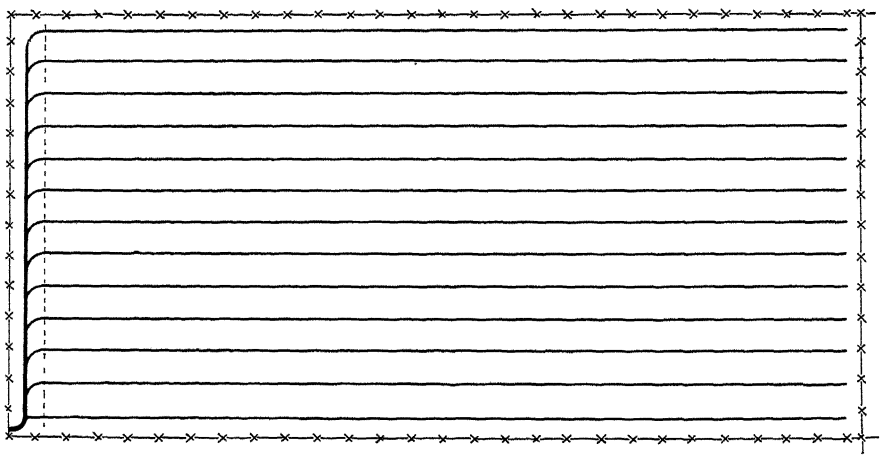

FIG. 3

system Fig. 3. This system is not only the cheapest of the three to install, but will also give the best service.

Figures 4 and 5 show a field sloping toward an open ditch. In Fig. 4 each lateral empties directly into the open ditch. This means

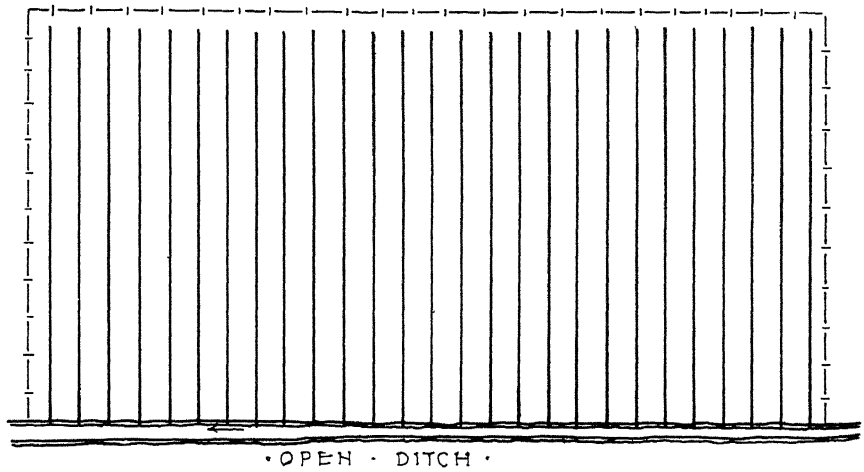

FIG. 4

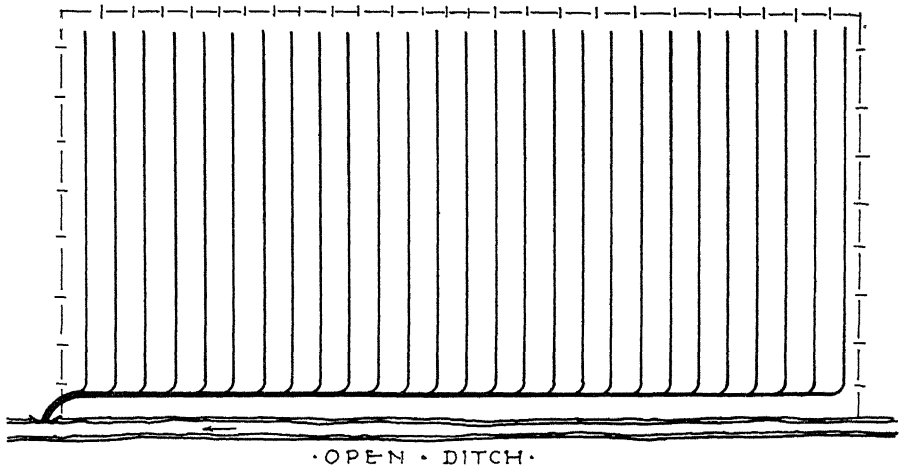

FIG. 5

27 outlets to construct and maintain. Very few farmers will go to the expense and trouble of constructing this number of good concrete outlets. The chances are that each outlet will be left without any protection. The end tile are almost sure to become misplaced or broken and clogged with weeds and soil. A clogged outlet will always mean poor drainage. No tile line is any better

than its outlet. In Fig. 5 a main has been placed parallel to the open ditch and empties into it at the lower end of the field. This system will require no more rods of trench or tile than in Fig. 4. The number of rods of laterals saved will equal the number of rods

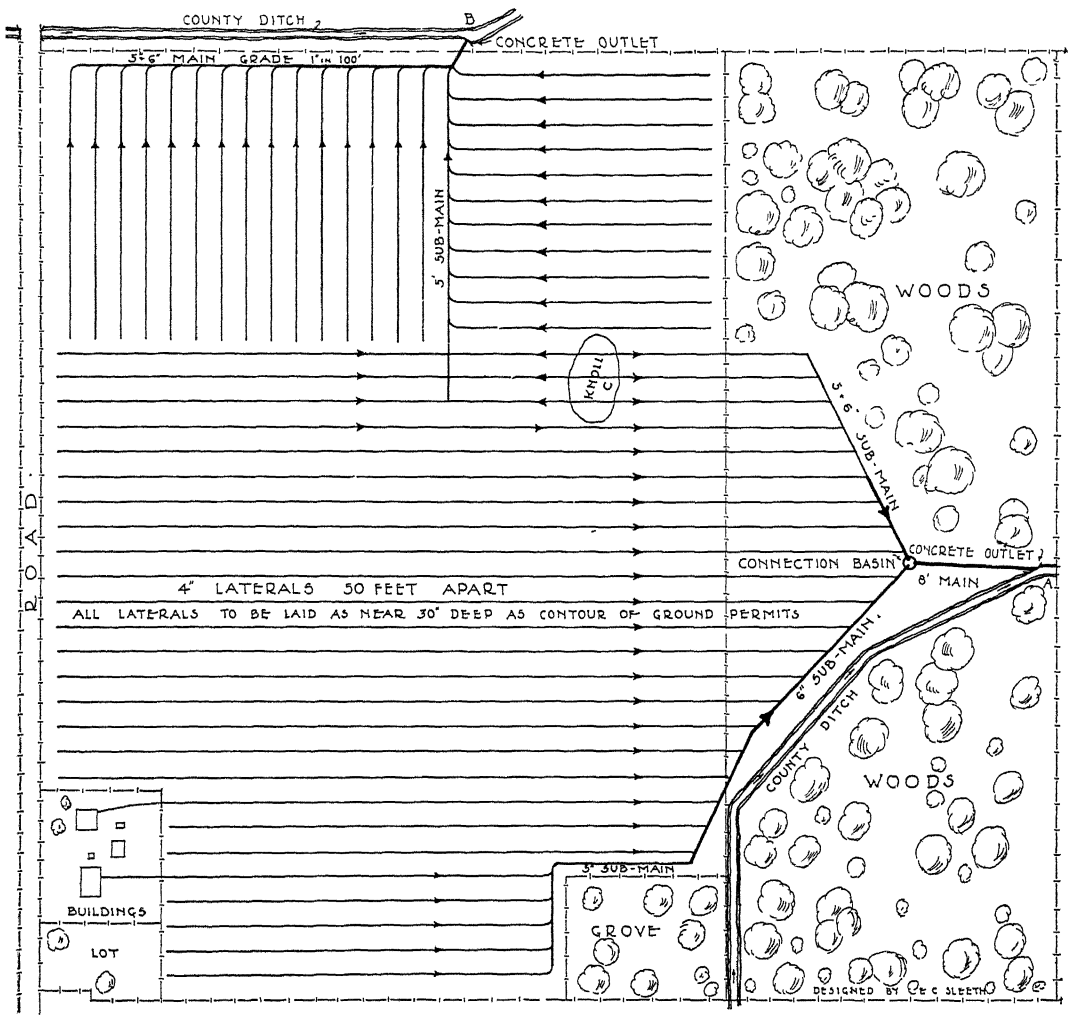

FIG. 6.—Drainage system on an Ashtabula County Farm

of main required. About the only additional expense of putting in the main is the difference in the cost of the main over an equal length of 4-inch laterals. This difference will be saved many times over in having but one outlet to construct and maintain and is extremely cheap insurance for the drainage system.

APPLICATION TO ACTUAL CONDITIONS

The examples used thus far have applied to rather ideal conditions. The problem of applying correct principles of drainage layout to actual farms is often more difficult. Figure 6 shows the drainage layout on the farm of Dwyer Brothers, Andover, Ohio. The system drains 60 acres. The slope of the ground varies from 1 to 8 inches per hundred feet. Practically every point of the compass is represented by the direction of slope on different parts of the farm. The natural outlet was into two different open county ditches at "A" and "B." By placing mains parallel to the county ditches the number of concrete outlets has been kept down to one for each county ditch. If this had not been done there would have been at least 30 outlets to construct and maintain instead of two. The shortest lateral is 35 rods and the longest over 100 rods. Where a knoll was encountered as at "C" the laterals were simply run up over it, breaking the grade at the crest. Thus part of a lateral passing thru the knoll "C" discharges into one outlet and part into the other. As a general rule the laterals run in the direction of greatest slope. But too strict adherence to this principle would have resulted in a very irregular drainage system.

No two farms present the same drainage problem. But so long as there is an outlet available a satisfactory drainage scheme can be devised for any farm needing systematic drainage. If the topography is rolling and the direction of slope is evident at all points, a good drainage layout may be devised without the use of a level. But it is never safe to put too much confidence in the eye as a levelling device. The use of a drainage level may point the way to a much simpler system than otherwise would have been thought possible. When a drainage scheme has been decided upon a simple map showing the location of all tile lines should be considered as an essential part of the work.

THE PROPER SIZE OF TILE MAIN

Three factors determine the proper size of main for a given drainage system. These factors are: (1) area of the drainage basin, (2) slope of the ground, and (3) the drainage coefficient used.

The drainage coefficient is the depth of water in inches over the entire drainage basin that a tile is capable of removing in 24 hours. For most conditions, where the main is designed to carry the water from a system of laterals with no surface inlets, use the $\frac{3}{8}$-inch drainage coefficient. If surface inlets are to be provided, a $\frac{1}{2}$-inch coefficient may not be large enough.

USE OF DRAINAGE CHART SHOWN IN FIGURE 7

The number of acres drained for a ⅜-inch and a ½-inch drainage coefficient are shown at the right of the chart. The slope in feet per hundred is indicated by the vertical lines and the size of tile by the diagonal lines.

Suppose there is a 70-acre field to be drained and the slope of the ground is found to be .3 of a foot per hundred. If no surface inlets are to be provided, a ⅜-inch coefficient should be used. The

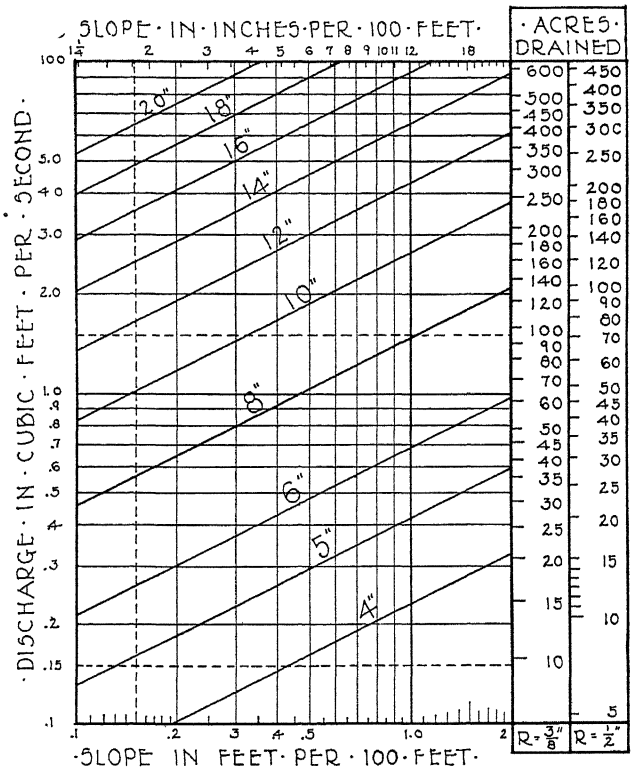

FIG. 7.—The correct size of tile to be used depends upon the area drained and the grade of the installed tile.

vertical line at .3 feet slope intersects the horizontal line of 25 acres in the space included between diagonal lines representing 8-inch and 10-inch tile. This shows an 8-inch tile to be too small and a 10-inch larger than necessary. But since there are no intermediate sizes between 8-inch and 10-inch tile, a 10-inch main is the proper size to use.

For information on the construction of tile drains the reader is referred to Extension Bulletin "Installing Farm Drainage Systems," published by this department.